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PACDN009

5-Channel ESD Protection Array

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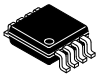


MSOP 8
MR SUFFIX
CASE 846AB

Product Description

The PACDN009 is a diode array designed to provide 5 channels of ESD protection for electronic components or sub−systems. Each channel consists of a pair of diodes which steers an ESD current pulse to either the positive (V_P) or negative (V_N) supply. The PACDN009 protects against ESD pulses up to ±15 kV Human Body Model (100 pF capacitor discharging through a 1.5 kΩ resistor), and ±8 kV contact discharge, per International Standard IEC 61000−4−2.

This device is particularly well−suited for portable electronics (e.g., cellular phones, PDAs, notebook computers) because of its small package footprint, high ESD protection level, and low loading capacitance. It is also suitable for protecting video output lines and I/O ports in computers and peripherals and is ideal for a wide range of consumer electronics products.

The PACDN009 is supplied in an 8−lead MSOP package and is available with RoHS compliant lead−free finishing.

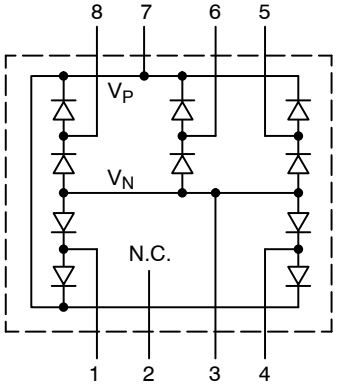
Features

- Five Channels of ESD Protection
- ±8 kV Contact, ±15 kV Air ESD Protection per Channel (IEC 61000−4−2 Standard)
- ±15 kV of ESD Protection per Channel (HBM)
- Low Loading Capacitance (3 pF Typical)
- Low Leakage Current is Ideal for Battery−Powered Devices
- Available in Miniature 8−Pin MSOP Package
- These Devices are Pb−Free and are RoHS Compliant

Applications

- Consumer Electronic Products
- Cellular Phones
- PDAs
- Notebook Computers
- Desktop PCs
- Digital Cameras and Camcorders
- VGA (Video) Port Protection for Desktop and Portable PCs

ELECTRICAL SCHEMATIC



MARKING DIAGRAM

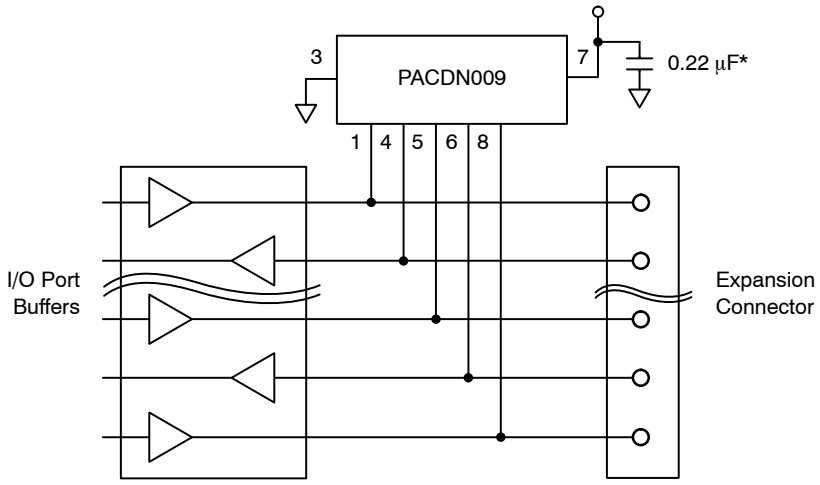
009R = PACDN009MR

ORDERING INFORMATION

Device	Package	Shipping†
PACDN009MR	MSOP 8 (Pb−Free)	4000/Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

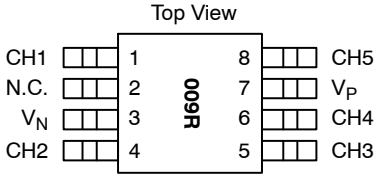
TYPICAL APPLICATION CIRCUIT



Handheld/PDA ESD Protection

* Capacitor should be placed as close as possible to Pin7.

PACKAGE / PINOUT DIAGRAMS



PACDN009
8−Lead MSOP Package

Table 1. PIN DESCRIPTIONS

Pin	Name	Type	Description
1	CH1	I/O	ESD Channel
2	N.C.	–	No Connect
3	V_N	GND	Negative Voltage Supply Rail or Ground Reference Rail
4	CH2	I/O	ESD Channel
5	CH3	I/O	ESD Channel
6	CH4	I/O	ESD Channel
7	V_P	Supply	Positive Voltage Supply Rail
8	CH5	I/O	ESD Channel

SPECIFICATIONS

Table 2. ABSOLUTE MAXIMUM RATINGS

Parameter	Rating	Units
Supply Voltage (V_P – V_N)	6.0	V
Diode Forward DC Current (Note 1)	20	mA
Operating Temperature Range	−40 to +85	°C
Storage Temperature Range	−65 to +150	°C
DC Voltage at any Channel Input	(V_N – 0.5) to (V_P + 0.5)	V
Package Power Rating	200	mW

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Only one diode conducting at a time.

Table 3. STANDARD OPERATING CONDITIONS

Parameter	Rating	Units
Operating Temperature Range	−40 to +85	°C
Operating Supply Voltage (V_P – V_N)	0 to 5.5	V

Table 4. ELECTRICAL OPERATING CHARACTERISTICS (Note 1)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I_P	Supply Current	(V_P – V_N) = 5.5 V			10	μA
V_F	Diode Forward Voltage	I_F = 20 mA	0.65		0.95	V
I_{LEAK}	Channel Leakage Current			±0.1	±1.0	μA
C_{IN}	Channel Input Capacitance	@ 1 MHz, V_P = 5 V, V_N = 0 V, V_{IN} = 2.5 V (Note 2)		3	5	pF
V_{ESD}	ESD Protection Peak Discharge Voltage at any Channel Input, in System a) Human Body Model, MIL−STD−883, Method 3015 b) Contact Discharge per IEC 61000−4−2 c) Air Discharge per IEC 61000−4−2	 (Note 2) (Note 3) (Note 4) (Note 4)	 ±15 ±8 ±15			kV
V_{CL}	Channel Clamp Voltage Positive Transients Negative Transients	@ 15 kV ESD HBM			 V_P + 13.0 V_N – 13.0	V

1. All parameters specified at T_A = 25°C unless otherwise noted. V_P = 5 V, V_N = 0 V unless noted.
2. From I/O pins to V_P or V_N only. V_P bypassed to V_N with a 0.22 μF ceramic capacitor (see Application Information for more details).
3. Human Body Model per MIL−STD−883, Method 3015, $C_{Discharge}$ = 100 pF, $R_{Discharge}$ = 1.5 kΩ, V_P = 5.0 V, V_N grounded.
4. Standard IEC 61000−4−2 with $C_{Discharge}$ = 150 pF, $R_{Discharge}$ = 330 Ω, V_P = 5.0 V, V_N grounded.

PERFORMANCE INFORMATION

Input Capacitance vs. Input Voltage

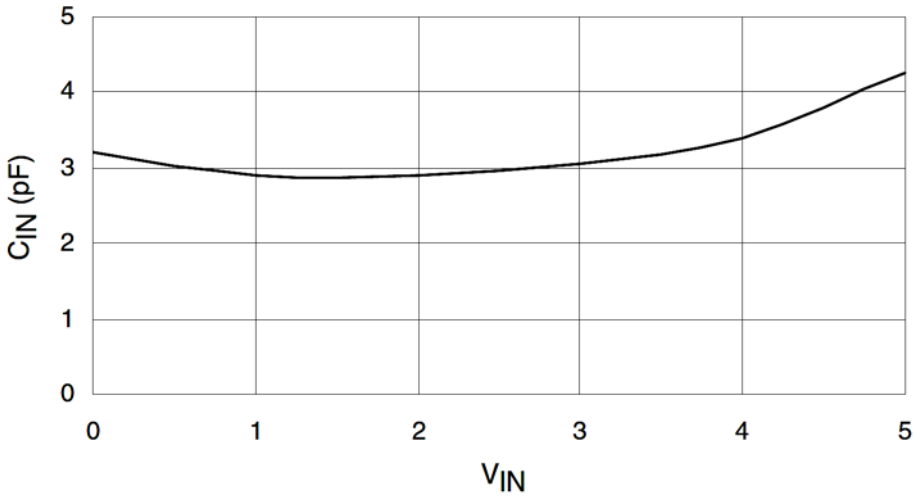


Figure 1. Typical Variation of C_{IN} vs. V_{IN}
(V_P = 5 V, V_N = 0 V, 0.1 μF Chip Capacitor between V_P and V_N)

APPLICATION INFORMATION

Design Considerations

In order to realize the maximum protection against ESD pulses, care must be taken in the PCB layout to minimize parasitic series inductances on the Supply/Ground rails as well as the signal trace segment between the signal input (typically a connector) and the ESD protection device. Refer to Figure 2, which illustrates an example of a positive ESD pulse striking an input channel. The parasitic series inductance back to the power supply is represented by L_1 and L_2. The voltage V_{CL} on the line being protected is:

$$V_{CL} = \textit{Fwd Voltage Drop of } D_1 + V_{SUPPLY} + L_1 \times d(I_{ESD})/dt + L_2 \times d(I_{ESD})/dt$$

where I_{ESD} is the ESD current pulse, and V_{SUPPLY} is the positive supply voltage.

An ESD current pulse can rise from zero to its peak value in a very short time. As an example, a level 4 contact discharge per the IEC61000−4−2 standard results in a current pulse that rises from zero to 30 Amps in 1 ns. Here $d(I_{ESD})/dt$ can be approximated by $\Delta I_{ESD}/\Delta t$, or $30/(1x10^{-9})$. So just 10 nH of series inductance (L_1 and L_2 combined) will lead to a 300 V increment in V_{CL}!

Similarly for negative ESD pulses, parasitic series inductance from the V_N pin to the ground rail will lead to drastically increased negative voltage on the line being protected.

Another consideration is the output impedance of the power supply for fast transient currents. Most power supplies exhibit a much higher output impedance to fast transient current spikes. In the V_{CL} equation above, the V_{SUPPLY} term, in reality, is given by (V_{DC} + I_{ESD} x R_{OUT}), where V_{DC} and R_{OUT} are the nominal supply DC output voltage and effective output impedance of the power supply respectively. As an example, a R_{OUT} of 1 Ω would result in a 10 V increment in V_{CL} for a peak I_{ESD} of 10 A.

If the inductances and resistance described above are close to zero, the rail−clamp ESD protection diodes will do a good job of protection. However, since this is not possible in practical situations, a bypass capacitor must be used to absorb the very high frequency ESD energy. So for any brand of rail−clamp ESD protection diodes, a bypass capacitor should be connected between the V_P pin of the diodes and the ground plane (V_N pin of the diodes) as shown in the Application Circuit diagram below. A value of 0.22 μF is adequate for IEC−61000−4−2 level 4 contact discharge protection (±8 kV). Ceramic chip capacitors mounted with short printed circuit board traces are good choices for this application. Electrolytic capacitors should be avoided as they have poor high frequency characteristics. For extra protection, connect a zener diode in parallel with the bypass capacitor to mitigate

the effects of the parasitic series inductance inherent in the capacitor. The breakdown voltage of the zener diode should be slightly higher than the maximum supply voltage.

As a general rule, the ESD Protection Array should be located as close as possible to the point of entry of expected electrostatic discharges. The power supply bypass capacitor mentioned above should be as close to the V_P pin of the Protection Array as possible, with minimum PCB trace lengths to the power supply, ground planes and between the signal input and the ESD device to minimize stray series inductance.

Additional Information

See also ON Semiconductor Application Notes AP209, “Design Considerations for ESD Protection” and AP219, “ESD Protection for USB 2.0 Systems”.

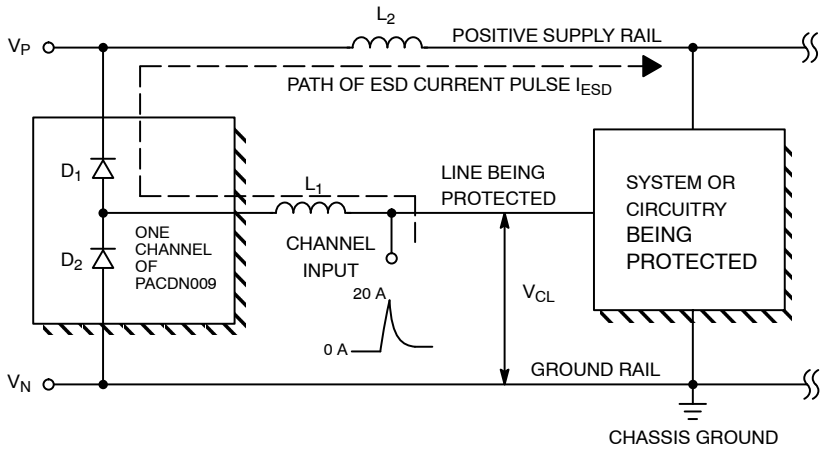
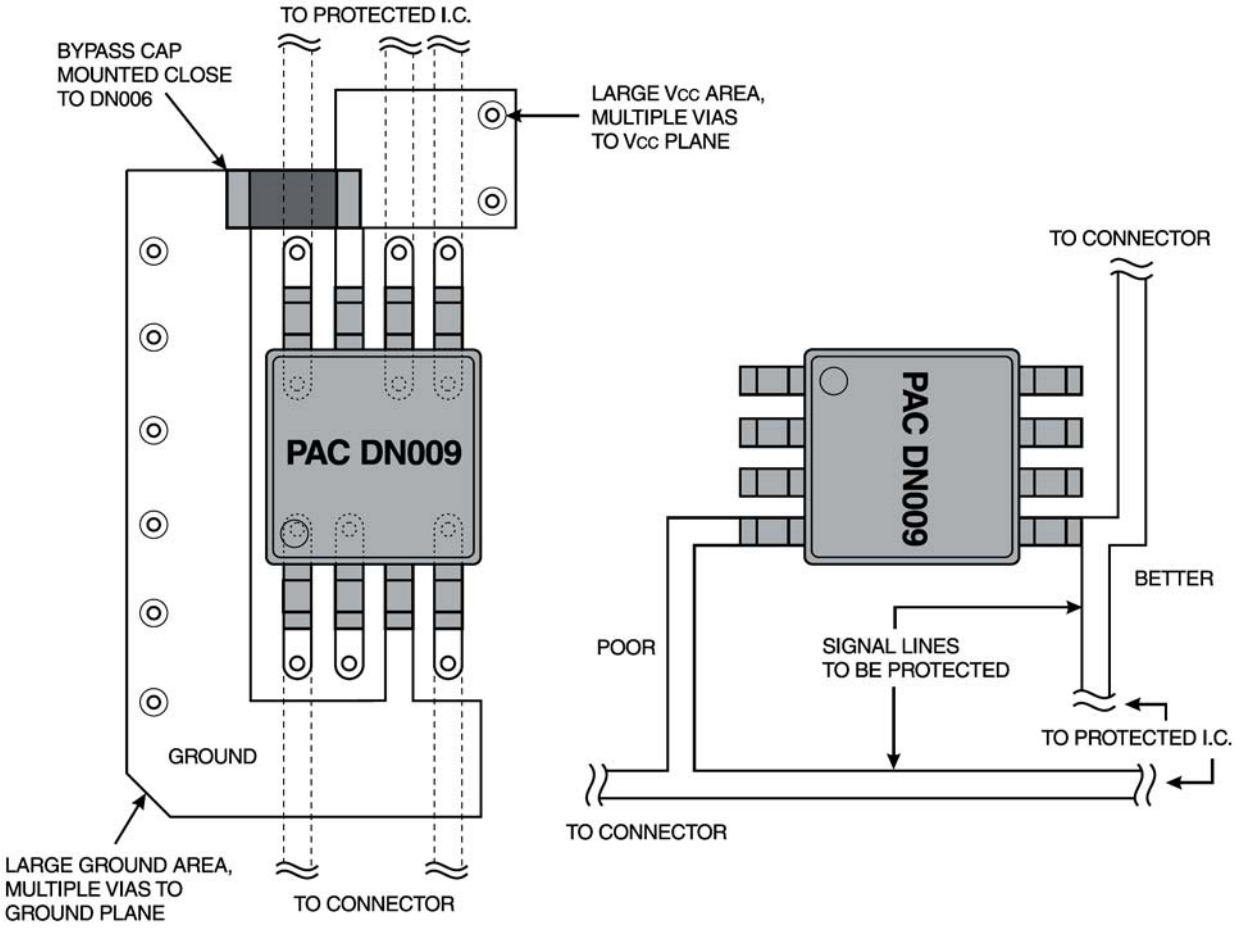


Figure 2. Application of Positive ESD Pulse between Input Channel and Ground



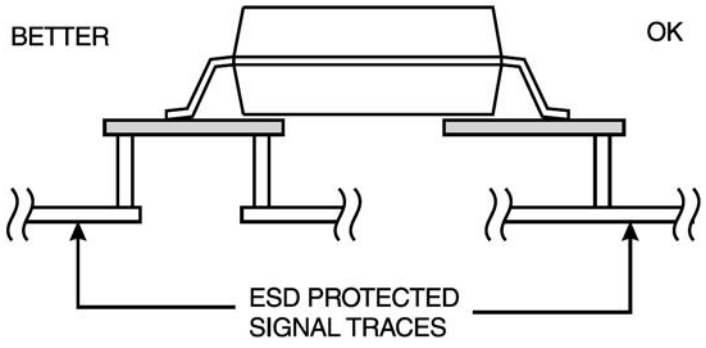
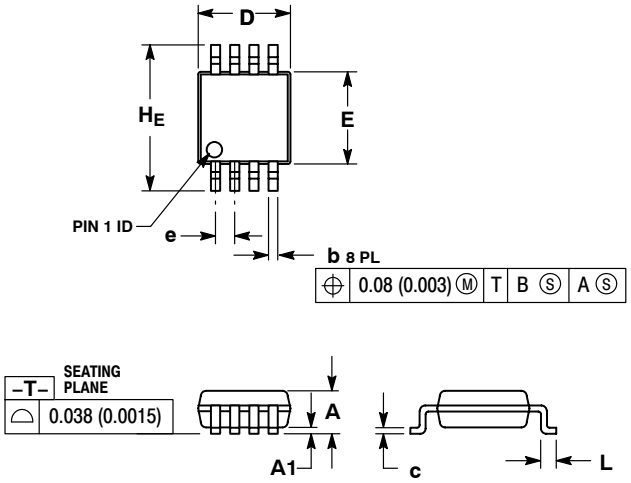


Figure 3. PCB Layout Recommendation

PACDN009

PACKAGE DIMENSIONS

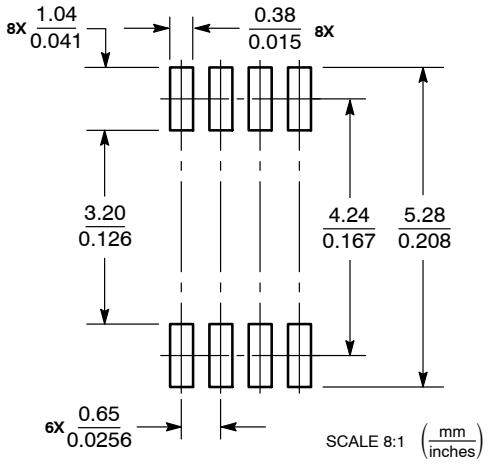
MSOP8
CASE 846AB−01
ISSUE O



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. 846A−01 OBSOLETE, NEW STANDARD 846A−02.

	MILLIMETERS			INCHES		
DIM	MIN	NOM	MAX	MIN	NOM	MAX
A	−−	−−	1.10	−−	−−	0.043
A1	0.05	0.08	0.15	0.002	0.003	0.006
b	0.25	0.33	0.40	0.010	0.013	0.016
c	0.13	0.18	0.23	0.005	0.007	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	2.90	3.00	3.10	0.114	0.118	0.122
e	0.65 BSC			0.026 BSC		
L	0.40	0.55	0.70	0.016	0.021	0.028
H_E	4.75	4.90	5.05	0.187	0.193	0.199

SOLDERING FOOTPRINT*



*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PUBLICATION ORDERING INFORMATION

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